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A Survey: Different Techniques in Image Super Resolution

Jetashri J.Shinde, Prof. A.S.Shirsat

Department of Electronics & Telecommunication Engineering, Smt. KashibaiNavale College of Engineering,

Vadgaon Bk. Pune, India

ABSTRACT: Image processing, compute vision, remote sensing and surveillance are some of field where high resolution image plays an important role.Super resolution is technique which enhances the quality of low resolution image and converts it into high resolution images to offer better visualization. As image super resolution problem is an ill-posed problem. A number of algorithmsoffer super resolution to make system simpler, effective and robust. For that new super resolver algorithm is introduced every day. On the basis of reconstruction method for high resolution image different super resolution algorithm.

KEYWORDS: KSV-D, Sparse Representation, Dictionaries, Regression.

I INTRODUCTION

As the digitalization of world increases necessity of high definition images is also increases everywhere for better result and accuracy. High resolution (HR) images has wide field of application where whole work is depends on such images. Super resolution (SR) is mainly used in area like image processing, medical imaging, remote sensing and digital entertainment computer vision. Because of more application super resolution became one of the attractive topics for research.

Basically SR process is ill-posed inverse problem because of lack of low resolution (LR) image. There are some algorithms which can resolve this problem with different methods. Interpolation based algorithm is one of it. Interpolation is interdependent on resampling process. It is used for enlarging original image. There are some interpolation methods used for super resolution ie. Interpolation Kernel, Nearest Neighbour Interpolation, Quadratic Interpolation, Cubic Interpolation, Bilinear Interpolation every method has its pros and cons depends on the bands and number of pixels required in processing [16]. Registration based algorithm is another method where registration is the process of combining the different low resolution image captured with reference to the single image and processes that LR image to produce fine high resolution image without any error. Firstly capturing different images of the same scene at different time with different. Then different restoration techniques need to be used to alien that LR image in single plane. After aliening all LR images fused to produce HR image [17]. In example based method HR image is reconstructed by employing specific dictionary for matching patches. LR image lost the high frequency details which can be found by pairing the HR-LR patches to estimate HR image [18].

Example learning based method use machine learning to find LR-HR relation. Author freeman introduces the markov random field (MRF) to build relationship between LR and HR image. To remove artifacts comes in MRF new method proposed named neighbor embedding. Due to over and under fitting in neighbor embedding blurring reduces quality. Using sparse coding this problem resolved. To reduce robustness and computational cost KSV-D based sparse dictionary proposed. Mapping from LR domain to HR domain take more time so simplest regression method is introduced with KSV-D sparse dictionary.

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Sparse dictionary is the main part of the system including SR phase. The matrix of the sparse coefficient is multiplied with the trained dictionary to generate HR image of Instead of the only a regression used for super resolution, KSV-D make it less time consuming method with less computational cost [6].

II. OVRVIEW OF SR TECHNIQUE

Zhiliangzhu, FangdaGue et al. proposes a fast single image super resolution via self-example learning and sparse representation. In this paper with the replacement of straight forward orthogonal matching pursuit algorithm in k-singular value decomposition algorithm (KSV-D) produces new self-example learning method. If we consider different SR method this small dictionary is a compact of patch pairs which is capable storing of local and global information simultaneously. This dictionary increases the computational efficiency [1].

Junaid Ahmed, ReinhardKlette present a coupled multiple dictionary based method. Higher resolution patches cannot be obtained from the patch smoothening method. So LR patches and HR patches are separated to make a trained dictionary depending on their geometric property. Clusters are selected on the condition of scale invariant feature. LR and HR dictionary are trained for each cluster along with the mapping function. To make proper dictionary sparse coefficient and mapping matrix are calculated for every LR patches. HR patches also reconstructed by the sparse representation and mapping matrix. This method gives the high resolve patches with high frequency component [2].

MahmoodAmiri, AlirezaAhmadifard et al. proposed a fast approach towards single image super resolution using dictionary learning. Most of the existing SR method has high computational cost, in this paper main aim of the author is to learn high frequency details and decrease the computational cost with reconstruction accuracy. For every patch LR and HR dictionaries are created. Local HR dictionaries are constructed for input image by removing LR components and patches are reconstructed using neighbourhood patches and dictionary. Patches extraction method is used to increase the accuracy and to lower the computational cost [3].

Jun-Jie Huang and Wan-Chi Siu present a learning based SR method ie. Hierarchical Decision Tree. This method is inspired by random forest method. LR patches are classified by performing binary test under the decision making tree technique into regression process and classification process. The Cascaded multiple layer of decision making tree increases the SR result [4].

Jianchao Yang, John Wright et al. In this paper a robust method for super resolution is proposed. Out of all machine learning techniques sparse representation using sparse dictionary is effective and robust. LR and HR dictionaries are created with reference to the patch pair of LR and HR image. By applying sparse representation to every LR patch it result in some coefficient of that representation. That coefficient was used for reconstruct HR image [5].

Muhammad Sajjad, IrfanMehmood et al. represent sparse coded image super resolution method bases on regularized orthogonal matching pursuit. Only the use of KSV-D trained dictionary was not enough in the case of medical images .More resolution, clarity, fast processing technique required in medical field. Over the KSV-D regularized orthogonal matching pursuit has transparency and greediness of OMP with the robustness of L_1-minization which increase accuracy and robustness[6].

In this paper author SaeidehSarmadi, ZariShamsa presents a new approach towards image super resolution. This method is mainly divided in three sections up sampling, de-blurring, de-noising. These three steps play an important role in the reconstruction of HR image. Up sampling is held with interpolation method, blur will be removed by unified probabilistic model and noise can be removed by spatially adaptive iterative filtering method[7].

Xiu Zhang, Wei Zhou et al. proposed a reconstruction based image super resolution using fusion of KSV-D and semi coupled dictionary learning. KSV-D requires less time to train dictionaries. Semi-coupled dictionary learning is sparse representation dictionary learning. Unification of this two method increase quality of HR image and reduce dictionary training time nearly four times[8].

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In this paper Kaibing Zhang, Dacheng Tao et al. present multiple linear mapping algorithms (MLM) for the super resolution of image .MLM work on LR subspaces to convert it into HR subspaces. As the LR-HR feature share same representation coefficient mapping estimate the match model among those learned function[9].

VaishaliR.bagul, varsha M. Jain. In this paper all super resolution methods are studied. To make image more smoother learning based SR method combine together. Total variation regularization method separates the image into high frequency component and low frequency component. Learning based process is used to get HR output image. At the last stage 2D Haar Wavelet Transform helped image to look smoother [10].
In this paper Hong Chang, Dit-Yang Yeun eta al. work on the super resolution using neighbour embedding based on ideas from manifold learning. Mainly they propose a new way to generalize the training images so that their contribution in patch processing will increase to get HR images as a result [11].

Zyangyang Wang, Yingzhen Yang et al. present a different way of learning based super resolution using external as well as internal examples. Usually either external or internal examples were used for super resolution but in this paper both examples are used to achieve something new. Loss function defines using sparse coding based on external example and epitomic matching based on internal example. To make a balance between these two examples corresponding adaptive weight comes in picture [12].

Qiang Wang, Xiaoou Tang et al. In this paper new ultimate method of learning based super resolution is presented. The set of low resolution image and high resolution image were integrated using SR reconstruction constraint and image co-occurrence prior in general probabilistic framework. For the fast implementation of SR algorithm adaptive locality sensitive hashing algorithm is used [13].

KaibingZang, XinboGao proposes a new learning based a maximum a posteriori probabilistic framework. To remove the ill-posed problem in super resolution local and non-local regularized prior of LR image were learned. To make effective SR method non-local priorand steering kernel regression used to learn local prior fused together [14].

To remove the non-local similarity in non-local autoregressive model (NARM) used and taken as data fidelity in sparse representation model. So author Weisheng Dong, Lie Zhang proposed a SR method using NARM which approximate the pixel as a linear combination of its non-local neighbouring pixel [15].

III DISSCUSSION

As super resolution (fig no.1) has many methods to reconstruct higher quality image from low resolution image, in broad way there are three method used for image super resolution

- Interpolation based SR method
- Reconstruction based SR method
- Example based SR method

Every method has some plus point and different technique to deal with super resolution problem. All details about these methods are explained in table no 1.
Example based method has maximum advantages than other two method. Example based method classified into three sub methods learning method, regression method and sparse coding. To make example learning based method more robust and fast KSV-D trained dictionaries used with linear regression. Some past effective method of learning based method is compared below in table 2.

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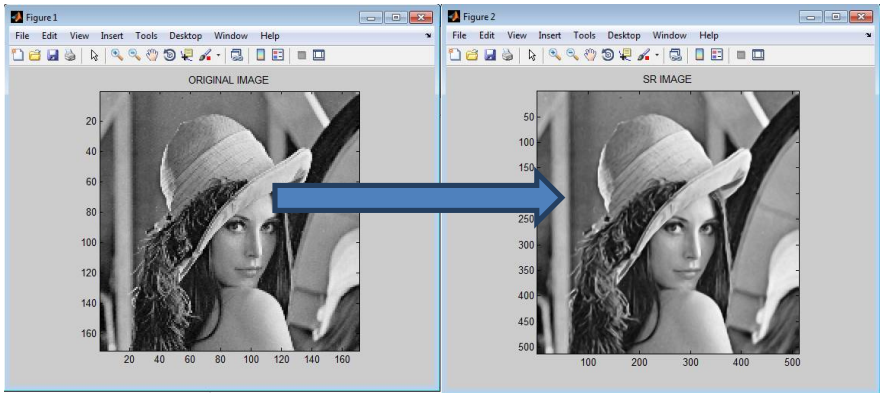

FIG.1. SUPER RESOLUTION

TABLEI
COMPARISON OF SR METHOD USED FOR IMAGE RECONSTRUCTION

Sr.no	Methods	Algorithms	Processing	Depend on	Advantages
1	Interpolation based method	• Nearest neighbor interpolation • Bi-cubic interpolation • Bilinear interpolation	Estimate new pixel from neighbor pixel, interpolate missing pixel value into image to create HR image.	Pixel processing	Simple and easy to implement, fast computation
2	Reconstruction based method	• R-SR method • Probabilistic method • Kernel steering	Contains three steps 1.image registration 2.image fusion 3. post processing	Rational prior constraint, magnification factor	Image fusion, Image overlay, change detection
3	Example based method	• Markov random field • Neighbor embedding • Sparse coding	Estimating HR image by employing dictionary of patch correspondence to find relation between LR-HR patch.	LR-HR patch relation , training dictionary	Require very few LR images, faster, more versatile, high magnification factor

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TABLE NO. 2
COMPARISON OF LEARNING BASED METHOD

Sr.No	Example based method	Magnification factor	Computation time	Advantage and disadvantage
1.	Markov random field	Low	more	: Use for low level image. : artifact at edges, low level quality
2.	Neighbor embedding	Medium	medium	: remove artifact : blurring during LR patch making
3.	SR with single dictionary	High	Less	:reduced blurring and remove artifact :use single dictionary
4.	SR with multi-dictionary	High	Less	: more accurate ,more robust

IV. CONCLUSION

Transforming low resolution image into high resolution is big task. To resolve this task different methods of super resolution are compared and learned. From the discussion efficient methods for super resolution is exhibited.
Interpolation base method is fast and simple with low magnification factor. Reconstruction based method typically requires low resolution image of same scene with different angle and position. This conventional method gets sophisticated by R-SR method, Probabilistic method, Kernel steering etc.Example based method require less number of LR image as compare to other. To make system more flexible this method can easily adapt with new training model and different data base. Using this versatile method the system could be robust. Hence this adaptive property gives this method more future scope.

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